MASTER OF SCIENCE
IN
SYSTEMS ENGINEERING

KALMAN FILTERING OF FDOA/TDOA MISSILE TRACKING SYSTEM

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The accuracy of a tracking system designed to determine the time, space and position information (TSPI) of an airborne missile by detecting its telemetry signal at a number of receiver sites is investigated. Doppler frequency measurements are converted to range differences between the missile and receiver sites, whose locations are known in three dimensions. An algorithm then utilizes these range differences to obtain the missile TSPI. The accuracy of the TSPI is a function of the measurement precision and the signal-to-noise ratio at the receiver sites.

This thesis examines the characteristics of the TSPI accuracy and investigates how a Kalman Filter can be used to enhance the accuracy of the TSPI.

DoD KEY TECHNOLOGY AREA: Sensors

KEYWORDS: Kalman Filter, Range Difference of Arrival (RDOA), Time Difference of Arrival (TDOA), Frequency Difference of Arrival (FDOA)

PREDICTION OF WIRELESS COMMUNICATION SYSTEMS PERFORMANCE IN SHIPBOARD COMPARTMENTS IN THE 2.4 GHz ISM BAND

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A physical understanding and consequent mathematical modeling of RF energy in naval indoor environments is of vital importance to the usability and effectiveness of communication systems used by Navy. Over the last few years, there is a growing interest in placing Wireless Local Area Networks (WLANs) in ships and submarines. Especially large ships yet to be constructed are designed with increased electronic systems but limited personnel. Reliable electronic systems will be crucial for efficient ship operation and survivability.

This thesis investigates the feasibility of deploying a physical model called Numerical Electromagnetic Code-Basic Scattering Code (NEC-BSC) to simulate confined naval compartments in the 2.4 GHz Industrial Scientific Medical (ISM) band. More specifically, using NEC-BSC the coverage area, the number and positions of transmitters and observation points and the statistics of Radio Frequency (RF) signal distribution were described. The area specifically targeted for this research was a typical two-story missile room. Additionally, some important conclusions regarding the validity of NEC-BSC for indoor applications are presented and some recommendations for future research are provided.

DoD KEY TECHNOLOGY AREA: Command, Control, and Communications

KEYWORDS: Simulation of Signal Propagation, Indoor Radio Propagation, Typical Missile Room, NEC-BSC

DIGITAL LOW PROBABILITY OF INTERCEPT RADAR DETECTOR

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The function of a Low Probability of Intercept (LPI) radar is to prevent its interception by an Electronic Support (ES) receiver. This objective is generally achieved through the use of a radar waveform that is mismatched to those waveforms for which an ES receiver is tuned. This allows the radar to achieve a processing gain, with respect to the ES receiver, that is equal to the time-bandwidth product of the radar waveform. This processing gain allows the LPI radar to overcome the range-squared advantage of the ES receiver in conventional situations. Consequently, a conventional ES receiver can only detect an LPI radar at very short ranges (<3 nm).

The focus of this thesis was to develop an ES receiver to detect LPI radar signals with the same sensitivity as conventional pulse signals. It implements a detector which employs a technique, known as "deramping," that forms an adaptive matched filter to the linear FMCW LPI radar signal in order to achieve the processing gain that is equal to the received signal's time-bandwidth product. An experimental transmitter was built to emulate the radar signal with FMCW characteristics and transmitted through a standard gain horn. The transmitted signal is then received via a receiver horn, mixed down to an intermediate frequency (IF), sampled by an A/D convertor and digitally deramped using a Pentium II computer.

It was demonstrated that the LPI radar signal can be extracted from the noise background by means of digital deramping.

DoD KEY TECHNOLOGY AREA: Electronic Warfare

KEYWORDS: FMCW, LPI, LPI Radar, Deramp, PILOT, Chirp, Frequency-modulated Continuous Wave